providing occasional commentary in endnotes. Manuscript volume and folio numbers are given clearly but unobtrusively.

The book contains 13 full-page illustrations, including 11 of Harriot's manuscript sheets, and these give the reader a good sense of what it would be like to read the manuscripts themselves. Of course, transcriptions can be read more quickly and easily, and Stedall has provided a great service to Harriot scholars and to historians of algebra in reassembling and transcribing Harriot's *Treatise on Equations* for us. Her appendix on correlations between the work of Harriot and Viète, between Harriot's work and Torporley's notes, and between Harriot's manuscripts and his published work in the *Praxis* should also be very helpful to scholars. Harriot's algebraic notation and ideas were beautiful, clear, and groundbreaking, as any historian or mathematician who views his work in Stedall's *The Greate Invention of Algebra* will now finally be able to appreciate.

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Essays on the History of Mechanics: In Memory of Clifford Ambrose Truesdell and Edoardo Benvenuto
Edited by Antonio Becchi, Massimo Corradi, Frederico Foce and Orietta Pedemonte. Boston/Basel (Birkhäuser Verlag). 2003. ISBN 3764314761. 256 pp.

This volume of essays was the product of a conference held in Genoa in late 2001 to honor the memory of the eminent historians of mechanics Edoardo Benvenuto (1940–1998) and Clifford Truesdell (1919–2000). Truesdell was a master of the history of theoretical mechanics in the 18th century, while Benvenuto was the author of major works exploring the history of mechanics, civil engineering, and architecture. The essays are divided into three groups. The first group deals with theoretical mechanics with an emphasis on the themes and writings of Truesdell. Included here are essays by Jacques Heyman (theory of structures), Gleb Mikhailov (elasticity theory and structural mechanics), Sandro Caparrini (vectors), Giulio Maltese (Newtonian principles), and Piero Villaggio (impact theories). The second group recalls the work of Benvenuto on civil engineering and architecture, with survey articles by Karl-Eugen Kurrer (deformation method), Santiago Huerta (timbrel vaults), and Patricia Radelet-de-Grave (forces and vaults). Jacques Heyman provides an expository engineering analysis of large glazed windows found in late Romanesque and early Gothic churches. The third group consists of two historiographical articles, a piece by Louis L. Bucciarelli on evaluating error in past mechanics and an essay by David Speiser on history of science and history of fine art. For reasons of space I will discuss only two articles here: Caparrini's essay on the early history of vectors and Bucciarelli's essay on error in past mechanics.

Caparrini's essay won the Slade Prize from the British Society for the History of Science for 2004, a prize awarded biennially to the writer of an essay that makes a critical contribution to the history of science. It is a sequel to a study published in 2002 in the *Archive for History of Exact Science* on the discovery of the vector nature of angular velocity and moments. Caparrini showed that the vector concept emerged in research on the dynamics of rigid bodies between 1760 and 1835. In the present essay he looks at the work of the Italian mathematician Gaetano Giorgini (1795–1874) and the eminent French geometer Michel Chasles (1793–1880). According to standard accounts (e.g., [Crowe, 1967]) in the history of mathematics, the vector concept developed from attempts to represent complex numbers geometrically and from generalizations of these results by William Rowan Hamilton (1805–1865) and Hermann Grassmann (1809–1877). In this view modern vector calculus developed in the work of such physicists as Josiah Willard Gibbs

(1839–1903) and Oliver Heaviside (1850–1925) who adapted prevailing mathematical concepts to the needs of physical research. Caparrini shows that vector ideas were in fact already present in mechanics and geometry in the early 19th century, in research on moments and angular velocity, and in the analytic theory of polygons and polyhedra. His findings do not invalidate the standard history but they do show that the sources of vector calculus were more diverse and the spread of vector ideas more abundant than has been hitherto recognized. His study exemplifies Truesdell's conception of the history of science as "the analysis of specific concepts in their historical origins and settings" [Truesdell, 1980, 5].

In his essay Bucciarelli takes up the question of how and on the basis of what evidence we decide that an error has been committed by a scientific practitioner of the past. He observes that there is a natural tendency to emphasize successes and to dismiss what appear to be errors or confusions, even when these mistakes were not so regarded by the scientist's contemporaries. Truesdell himself was all too willing to call a spade a spade and to pass judgment on the people he was studying. Benvenuto, by contrast, tended to be gentler in his assessments when confronted with apparent examples of faulty science. Bucciarelli quotes historians Jed Buchwald and Sungook Hong, who set out criteria to evaluate past errors:

> This danger raises the question of what it means to assert that a scientist was mistaken. ... To justify doing so, the historian's critique should illuminate the point at issue in a historically-significant way; should not bring to bear knowledge that the subject could not possibly have possessed at the time; and should argue that the subject could reasonably have been convinced by a contemporary that he was in error. [Buchwald and Hong, 2003, 186, n. 58; quoted by Bucciarelli on pp. 42–43]

Of course, the difficult criterion here is the third one (we never know with certainty about hypothetical events), although in many cases it may be reasonably applied with some plausibility.

Bucciarelli relates the problem of historical error to an account by Truesdell of a 1731 experiment performed by the English natural philosopher William Gravesande (1688–1742). The experiment concerns the deflection of an elastic string when it is subject to a transverse load. Truesdell was very critical of both the experiment and the conclusion Gravesande derived from it, that there was a linear relationship between the load and the deflection. Bucciarelli shows that a closer analysis of the problem requires information about the constitutive behavior of the wire and this in turn requires some familiarity with wires in the early 18th century, a subject that "lies outside of Truesdell's field of view." Gravesande had in fact shown that in linearly elastic bodies with small deflections, the macro behavior is linear, a fact of definite importance. Bucciarelli's conclusion is based on a more nuanced physical analysis of the problem than Truesdell's, and it also takes into account factors not considered by him. A full historical account of the experiment requires consideration of corpuscular physics and some information about the craft technique and material culture of the time, things that may be difficult to reconstruct but that are necessary for an understanding of the experiment.

Truesdell was a strong proponent of the survey genre of historical writing. He eschewed the detailed reconstruction of older theories, believing that such studies tended to result in what he called "protophysics" [1980, 5, n. 3] and to detract from an appreciation of the historical sweep of past science. Benvenuto's preeminent contribution consisted of his 1991 survey of structural mechanics, a two-volume work extending from Archimedes (ca. 287–212 B.C.) in antiquity to Alberto Castigliano (1847–1884) in the second half of the 19th century. Although it is appropriate that the nonhistoriographical essays in the volume under review are surveys of their subjects, written by and for scientific practitioners, historians of mathematics will find the essays on theoretical mechanics and historiography of primary interest. All of the contributions to the volume are substantial studies and pay fitting tribute to the memories of Benvenuto and Truesdell.

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